

D. Lesson
from the Author
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AN
ESSAY
ON THE
METHOD
OF

Studying Natural History ;

BEING
AN ORATION

Delivered to the SOCIETAS NATURÆ STUDIO-
SORUM, at EDINBURGH, in the Year 1782.

By RICHARD KENTISH, *R*

M. D. F. A. S. Ed. President of the Society, and Member
of several Literary Societies, &c. &c.

L O N D O N :

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MDCCLXXXVII.

"Look thro' Nature, up to Nature's God."



POPE."

TO THE RIGHT HONORABLE

Lord Viscount Mandeville,

MY LORD,

I FEEL myself happy in the permission of dedicating this little work to your Lordship; and I flatter myself that its object will not appear unworthy that attention which Natural History deserves, as a part of polite education. The study of Nature forms one of the most pleasing and instructive amusements of youth;—it is become the favored topic of Princes, and the great delight of scientific men.—It has opened to our view, in its varied pursuits, a wide and extensive field of observation and improvement.—It has aided the arts, and proved the basis of science.—Its utility has recommended it to all ranks of society; and I hope

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that

that the observations which are here presented to your Lordship will serve to facilitate an acquisition, which will prove a source of rational entertainment, and important information, throughout the various periods of that elevated station which your Lordship is destined to fulfil. And that you may imitate the engaging example of your illustrious parents, and emulate their noble virtues, is the earnest wish of

My Lord,

Your Lordship's most obedient,

Humble Servant,

RICHARD KENTISH.

Gower-Street, Bedford-Square,

June 7, 1787.

PREFACE.

P R E F A C E.

WHEN the professed intention of an Author is mere utility, the acquirement of much fame is precluded, and he ought to feel himself happy if he escapes without censure.—Such, in the present instance, is my own case.—I do not in this performance stand forth as the Champion of Discovery, or the Inventor of Theory.—An unexpected occurrence laid the foundation of this Discourse, and a peculiarity of events has induced its publication. In the course of my studies at the University of Edinburgh, I necessarily became engaged in the pursuits of Natural History, and I soon perceived that a connected view
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of the science, in our own language, was wanting. An occasion offered for my exertions, and I ventured to arrange my ideas in a summary view of the subject before a Society of Naturalists in the University.

It was the wish of several learned friends that I should present my arrangement to the public; but I rejected such solicitation, in hopes of perfecting my views:—professional engagements, and an almost total abstraction from literary pursuits during an annihilation of a triennial rustication, prevented me from such an undertaking. At length, however, I was tempted to review my theme, and I have only now to regret that it was not longer delayed. The additions which a country life afforded me to make were so trivial, that

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my work may still appear imperfect. But I am not without hopes that it may, notwithstanding, possess sufficient merit for the purpose to which it is designed.—By presenting to the young Student a systematic view of the most approved methods of studying the three kingdoms, or grand arrangements of Nature, with the best authors on each, my Work will be found to comprize a totality which is not (as far as I can learn) to be met with in our own language.—I trust, therefore, as a General Introduction, it may have its use; and I have reasons for its present publication still more urgent. Having engaged in a Course of Lectures on Chemistry and the Materia Medica, I am induced to present my pupils with this view of the Method of Studying Natural History, being fully convinced that no real progress

gress in either of these sciences can be made without such study.—It is on these arguments alone that I venture to present my Essay to the perusal of the candid reader.

GENTLEMEN,

GENTLEMEN,

I Cannot enter on the exercise of that office to which you have elected me, without thanking you for the honor which such a choice has conferred upon me. I now feel the want of those talents which I have so often admired in others. Oratory is an acquisition, which I now would wish to possess. But the art of speaking is not to be acquired in a moment. Nature has not been alike bountiful in her gifts of speech. To speak well in public assemblies is an accomplishment not dependant on the natural Powers alone. Custom and Habit give confidence to the speaker, and thoughts and words, like mechanical operations, are facilitated by use, and improved by culture. Eloquence, is not however the distinguishing mark of a philosopher ; to think accurately,

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to speak justly and reason rightly, are objects of his attention. The flowers of rhetorick and the ornaments of speech he studies not. Though he admires them in others, he is apt to disregard them as useless and often prejudicial to philosophy. To improve the heart and instruct the head, are objects of his attention. You, Gentlemen, as a Society of Philosophers, will therefore, I trust, excuse the want of eloquence in your President; you will hearken to what he may say with readiness, and listen to the matter, regardless of the manner.

To thank you for the honor I have received is not sufficient; unprovided therefore as I am with a rich "wardrobe of words," unadorned as my argument may appear, I shall attempt to compensate for this defect by calling your attention for a few moments to objects worthy of your consideration. As an original Member of this Society,
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you will pardon me, if I presume to lay before you the History of this now respectable Institution. Your Society, Gentlemen, dates its Origin from the year 1782. A year distinguished for the number of ingenious and learned men in this University. The Students were indeed not so numerous as at present, but the names of men, who that year adorned the List, and particularly assisted in the formation of this Society, will long be remembered with pleasure, and mentioned with respect.

A set of Gentlemen from various parts of the world, whose parental climes differed more than their Opinions, united for the purpose of mutual improvement in the different branches of Natural History. Botany, and Mineralogy were their chief pursuits, and to procure specimens of the different Plants, and Minerals, their intention. For this purpose they met, and unanimously went in quest of their respective

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objects.

objects. Having for sometime continued to amuse themselves in this manner, some circumstances occurred which made them desirous of meeting for the purpose of imparting their discoveries; accordingly they met at each others rooms, and each in his turn entertained the rest with his success in collecting. The most curious specimens were produced and the general opinions received. We did not long continue this mode of meeting before we attracted the notice of the most eminent Naturalists in Edinburgh. The Professors of the University, with that Liberality which marks their character, offered every assistance to our enquiries. The College Museum was tendered to our use, the Professor of Natural History entertained us with the choicest specimens of his cabinets, entered his name upon our list of ordinary members, and became a constant attendant on our debates: How great the improvement
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we now receive from such attention, you all know. After this Acquisition to our number, our fame went abroad, Gentlemen of the most distinguished Talents associated with us, our illustrious Professors of Chemistry and Botany took their seats in this Society, its attendant members increased, regulations were found necessary, and a Code of Laws, simple but efficient, were established. Every Member in his turn gave in papers for discussion, a *Calendarium Floræ* was kept, observations from different quarters were received, we were no longer a Society of young uninformed students, Gentlemen of the first abilities and distinction honored us with their remarks, and Nobility itself added dignity to our list of members. Such is the History of our first Session. In the year 1783 our meetings were fashioned into a regular Society, Officers were appointed, Presidents were elected, and our numbers increased.

increased. The present Session has confirmed the Utility of such an Institution; and I trust, Gentlemen, your foundation is now too firm ever to fall. When I reflect on the small beginning and rapid improvement of this Society, I cannot help congratulating its Members on the prospects before them. The histories of few societies rise with such rapidity towards perfection; the state you have now attained, and the number of illustrious Characters that adorn your List of Members augurs prosperity. Your Society, I presume to hope, will flourish, and its name go abroad. At this seat of science it will prove a fruitful seminary of natural knowledge, and as its Members disseminate they will spread its Fame. To attempt an eulogy on the objects of your meetings will appear superfluous, I must content myself therefore with saying a few words on the study of Natural History. Such
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of my hearers as are already advanced far on the scale of science, will I trust pardon the liberty I take in addressing myself to the younger Members of this Society. To them I would observe that Natural History now makes a part of polite education, and the man who is ignorant of it will frequently be deprived of one of the greatest sources of self-amusement.

It would be no difficult matter to shew the utility, sublimity and importance of that science which "vindicates the ways of God to man," but I trust that none of my hearers will stand in need of arguments or logical reasoning, to convince them of the rank which the study of nature holds amongst the sciences. Every branch of natural History is now become an important part of literature, it is cultivated by the highest orders of society, even Princes themselves have laboured in the extensive field
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which it opens to their view, and their researches have been attended with success. The encouragement given to this study is of very ancient date.

Alexander the Great allowed Aristotle a considerable sum, to enable him to pursue this knowledge, and large sums of money have been expended in our own and other countries of Europe, in the formation of those collections which do honour to the taste of a refined people, and mark the munificence of an enlightened age. The attention of foreigners has been constantly attracted by these repositories of curiosities, and though the greater part of travellers are admitted but to gaze with wonder on the strange appearances presented to their view, yet to a philosophical enquirer, the effect is widely different. When he beholds the productions of different climates, and sees the varied form of nature; when he finds himself surrounded
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with the inhabitants of different elements, and divers countries; when he traces the variety of species, and infinitude of products; when he examines the contrast in size and shape of animals, the wonderful œconomy of Vegetables, and the properties of the Mineral kingdom, he is led into a thousand speculations on the appearances of life, the methods made use of to sustain the living principle, and the wonderful extent, and diversity of organized and unorganized matter. The arranged collection of art is not however the source from which the greatest knowledge is derived. The whole system of nature is to the Philosopher a grand Museum, and the properties of its contents the fit subject of his contemplation.

It is by such pursuits that the human intellect asserts its native dignity, and claims the ascendancy which it possesses. Every subordinate species

of the animal creation acts contented in a lesser sphere, and performs the part assigned it with instinctive quietude, but man contemplates on the things around him, surveys, examines, and admires; his capacity is adapted to complex enquiries, he is not satisfied with the bare inspection of facts, he marks effects, and dares to ask the cause. The aptitude of his mind is such, that the most complicated investigation is within the compass of his intelligence, and ideas the most abstract, are comprehended with simple facility. He tastes the pleasures of an imagination too fine for the gross conception of other animals, and pervades the secret paths of Nature.

To every order of society the study of nature cannot fail of being interesting; it is in a peculiar manner connected with the avocations of some men; it is the pedestal of philosophy, and the sole foundation of all
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her discoveries. The practical professions of mankind are frequently inseparable from the study of nature. The science of Medicine is a striking instance of this kind; the connection is so intimate, that we find the names of physicians constantly enrolled amongst the most eminent naturalists. The sciences of Chemistry, Botany, and Anatomy, which form the most material branches of medical education, cannot be attained without a partial knowledge of Natural History; and although a minute acquaintance with the multiplied objects of each department is tediously laborious, yet a general one is easy, useful, and necessary to the character of a polite scholar. Without pretending to a minute knowledge of the subject, or wishing to arrogate more information than you are ready to admit, I will venture to beg your indulgence whilst I say a few words to those who may be entering on this pleasing study.

The whole diversity of organized and unorganized matter, which presents itself to our view in the external or internal parts of the Earth, has been comprehended by the Naturalists under three grand classes or divisions, which have been called the Three Kingdoms of Nature, viz. The Mineral, 2. Vegetable, 3. and Animal.

By the aid of these general, and some subordinate distinctions, which will fall under our consideration, the study of Nature is facilitated, the various appearances of bodies, which at first sight seem innumerable, are brought under our review, and we are enabled to characterize them by peculiar marks. It is to this classification that we are indebted for that comprehensive knowledge which we are able to attain, and that acquaintance which we possess with the animate and inanimate parts of the Creation. The methods which have been used for this purpose, are the
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present objects of our attention. By detailing the principal systems which have appeared, I shall have an opportunity of remarking on the excellencies and defects of each, and be enabled to point out the proper guide for the conduct of beginners.

Mineralogy is that branch of Natural History, which falls first under our consideration. We shall view it in its most extensive sense, and by Minerals denote, not only such substances as are found in mines, as Metals, Semi-metals, Sulphur and Salts, but likewise all fossils that do not belong either to the Vegetable or Animal Kingdom. This study appears to be very ancient. The Jews and Egyptians in the time of Moses were acquainted with precious stones, and even the most rude and barbarous nations have been found to possess some knowledge of the ores of different metals. But it is only in modern times, amongst civilized and
learned

learned nations, that Mineralogy has assumed the form of a regular science. It is a branch of learning, whose cultivation and improvement requires both speculation and practice. Many nations in Europe have found it an object of political attention. In Sweden and Germany there are colleges in which it is regularly taught; it forms a distinct and honorable profession, like that of the divine, the physician, or the barrister, and its superior officers, form a part of the administration of the state. * The students are sent to foreign climates for the purpose of collecting rare and curious specimens. The Russians and Spaniards have lately adopted this plan, and the French have erected a Mineralogical School at Paris, to which a considerable stipend is annexed. Persons are employed in tracing subterraneous maps of the whole

* Kirwan's Elem. of Min. p. 28.

whole kingdom of France, and Mineralogical Voyages have been taken at the public expence. In our own country, which is allowed to be richer than France in mineral productions, the science of Mineralogy has received no encouragement from the public, and the study has been chiefly confined to a few Gentlemen of the Medical profession. Even Chemistry, which we shall attempt to shew, is the parent of Mineralogy, has been scarce attended to in England, whilst neighbouring nations have pursued it with enthusiastic ardour; it forms the favourite occupation, and even the most fashionable object of attention, not only of the middling, but even of some in the highest ranks of society. *

Before

* Among these says Mr. Kirwan, we may reckon in Russia, Prince Gallitzen: in Germany, Count Sickengen; in Italy, the Counts de Saluces, de Morozzo, and the Marquis de Gironi, Governor of Leghorn;

Before we detail the systems which have been professedly offered to the public, we should premise, that it has long been matter of controversy among the Naturalists, "Whether the characters of minerals should be taken from external appearances only, or from their internal properties as discovered by chemical agents? If it be granted that every art and science should be founded on permanent principles, there can be no doubt but the latter opinion is founded in truth, and that the internal properties of minerals are

Leghorn; in Geneva, Mr. de Saussure; in France, the Dukes de Chaulnes, Rochefoucault, and D'Ayen; the Counts de Lauraguais, la Garay, Milly, Tressan, and de la Tour d'Auvergne; the Marquisses de Courtenvaux, and de Courtivron; the Barons d'Olbach and de Servieres; Messieurs Trudaine, Lavoisier, Montigny, de Morveau; and among the Ladies, Madame la Presidente d'Arconville. To this List we may add the Earl Dondonald in Scotland, and Mr. Kirwan himself in England.

Kirwan's Elem. Min. Pref. iii. note.

are the only durable marks on which we can depend, in our researches on the unorganized, inanimate parts of matter. The study of Mineralogy therefore, necessarily requires the knowledge of the general principles of Chemistry, for which purpose I recommend to your attention, the Dictionary of Chemistry by M. Macquer, translated by Mr. Keir, whose notes are a valuable addition. The Chemical Essays of the Bishop of Llandaff, are valuable on account of their application to the arts; whilst the Elements of Chemistry by M. Fourcroy, contain all that is necessary for a beginner to study as the rudiments of the science. The works of many eminent chemical philosophers, as Bergman, Scheele, Lavoisier, Morveau and others who have written singly, or published papers in the different Periodical Transactions or Memoirs of learned Societies, as those of the Royal Society of Lon-

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don, Academie de Science of Paris, Stockholm and Peterburgh, &c. will give him great information. But the Dictionnaire de Chymie, now publishing by M. Morveau, in the Encyclopedie, is justly esteemed the first chymical work that ever appeared.

When a tolerable knowledge of Chemistry is once acquired, the study of Mineralogy will be easy; for we assume it as an established fact, that no real progress can be made in this Science independant of such a foundation. The early Systems were in this respect defective. We shall take a short view of them.

The earliest system of which I have any account, was that of Magn. Bergarter Bromel, published in 1730. He arranges all Mineral substances under the following classes. 1. Terræ. 2. Salia. 3. Sulphura. 4. Lapides. 1 Igne persistentes. 5. 2 Calcinabiles. 6. 3 Igne Vitrescentes. 7. Figurati. 8.

8. Petrifacta. 9. Calculi. 10. Semi-Metalla. 11. Metalla.

There are many mistakes in this work, and its fundamental error is the want of Chemical knowledge in the author.

In 1736, the celebrated Linnæus, Professor of Natural History at Upsal in Sweden, published a System, in which he comprehends all Minerals under three classes. 1. Petræ. 2. Mineræ. 3. Fossilia.

The work is defective in many particulars, but from the minute attention paid to species, may be useful for some purposes.

In 1747 J. G. Wallerius published a work which is in high esteem even at this day by many Naturalists. It is certainly useful for the study of species, but he has not availed himself of the aid of Chemistry. His divisions are, 1. Terræ. 2. Lapides. 3. Mineræ. 4. Concretæ.

In 1748, J. L. Woltersdorf sent into the world a system comprized under the following classes. 1. Terræ. 2. Lapides. 3. Salia. 4. Bitumina. 5. Semi-metalla. 6. Metalla. 7. Petrifacta. The last class is treated very fully, and as the branch is curious, it may afford instruction to those who particularly wish to pursue this part of Natural History.

In 1755, F. A. Cartheuser published a System of Mineralogy with the following divisions. 1. Terræ. 2. Lapides. 3. Salia. 4. Inflammabilia. 5. Semi-metalla. 6. Metalla. 7. Heteromorpha. Under the last class he includes the Petrifacta.

The System of J. H. G. Justus appeared in 1757, his divisions are, 1. Metalla. 2. Semi-Metalla. 3. Phlogistica. 4. Salia. 5. Petrificata. 6. Terrena. The work is said to treat copiously of the gems, but I have not been able to meet with it.

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In 1758 an anonymous publication appeared, of which Linnæus says "Vox Swabii, manus Cronstedti." He was right in supposing the work to be Cronstedt's. Whatever aid Swab afforded is unknown. The system has been uniformly attributed to Cronstedt, and since published in his name. It is this work which laid the foundation of the present improved state of Mineralogy. But it is highly probable that the writings of some distinguished philosophers, as Mr. Margraaf of Berlin, and Mr. Pott, who about this time published his *Lithogenesis*, were in some degree the cause of the improvement which took place. This system was the first which introduced Chemistry as the basis of the science. His classes, and genera and species, are drawn from the composition and internal nature of minerals, but the varieties from external appearance only. By this means the advantages of both systems are combined. The

The classes are 1. Terræ. 2. Salia. 3. Phlogistica. 4. Metalla. The work has been in general esteem with the chemical sect, and the student will find it of great use previous to his entering upon a minute investigation of species in the system delivered by Mr. Kirwan, whose researches place him far above the scale of ordinary writers. A system of six classes was published by Vogel, and a copious work on English fossils by Sir John Hill, but they do not appear to be worthy much attention. We ought however to remark, that not long ago some strenuous advocates have written in defence of the opinions which found the science on the external appearances of minerals only. Mr. Werner has written in the German language a Treatise on the external characters of Fossils, which is in high esteem. Mr. Romè de Lisle has likewise published a voluminous Treatise on the external forms of Chrystals, under which

which title he comprehends all those Fossils that are susceptible of a regular figure, which he imagines may be distinguished by the angles their planes make with each other, if there be no *heterogeneous matter* contained in them. The objections to this latter opinion are very obvious. There are many minerals which have no appearance of chrySTALLIZATIONS. There are likewise chrySTALLIZATIONS of no determinate figure, and the very form of chrySTALS often depends upon accident. Mr. Werner attempts to class minerals by the joint consideration of all their external properties; but that this combination of character is inadequate to the purpose will be apparent, by considering the mistakes which have happened in such a classification. So far from becoming acquainted with the nature of a mineral by such a superficial examination, we deceive ourselves, and may commit mistakes of serious consequence. We
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may reject fossils of high value, or remain unacquainted with minerals which contain the most precious substances. The ores of metals are often only to be known by chemical tests. Mr. Werner has placed among the *Micas* a green foliated substance;* which being sent to Mr. Bergman, proved to be a compound of marine salt of copper, and argillaceous earth. So much superior is chemical experiment to bare enquiry, that this mistake was detected in so small a quantity as a single grain. Mr. Kirwan has placed the excellency of chemistry in a striking point of view, by examining the mutability of those external properties which minerals possess. And as it is impossible to set the matter in a clearer light than he has done, we shall take the liberty of adding an abstract of his observations, which will corroborate

* Kirwan p. vii Pref.

corroborate the opinion we have labored to establish. That *colour* is a very deceitful appearance, is manifest to every one who knows that white quartz, white lead ore, and white calcareous iron ore, have exactly the same snow white colour. There are likewise some species of the ores of iron, manganese, cobalt and copper, of the same iron-grey colour, whilst wolfram and blende are of the same brownish black, &c : a change of texture frequently produces a change of colour; thus a lump of cinnabar, which is *dark red*, will become of a beautiful *florid red*, by simply reducing it into powder.

Transparency and *opacity* are common to a great variety of very different substances.

Coherence and *hardness* are properties equally ambiguous. When a body is so hard as to strike fire with steel, it has been supposed to be pure flint

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or siliceous earth, and this has been esteemed the most certain infallible test; but it is now known that well baked clay, and other substances, will exhibit this appearance.

Texture, in all its varieties, is common to substances widely different. Thus the fibrous is found in asbestos, shorl, some varieties of gypsum, pyrites, pumice, antimony, hæmatites, malachite, cobalt, and arsenical ores; the scaly in mica, lead and iron ores &c. &c.

The varieties of *shape*, even when regular and determinate, are innumerable. Mr. de Lisle finds nine varieties in that of fluor, thirty-two in the shape of calcareous spar, fourteen in that of gypsum, sixteen in that of quartz, besides its monstrous forms, equally regular as the rest; nineteen in that of felt, spar, &c. The same specific substance is not only susceptible of various shapes, but various substances

stances specifically different, assume the same shape. The native calx of arsenic, blende, cinnabar and grey copper ore, appear often in a tetrahædal form; zeolyte, fluor, common salt, galæna, in a cubic, &c.

The form of saline substances has been thought most permanent, but Mr. Pott assures us, that microcosmic salt assumes the figure of almost all other salts, viz. nitre, vitriol, sal ammoniac, allum, Glauber's salts, &c.* Mr. Macquer discovered that corrosive sublimate chrySTALLIZED by cooling forms needles, but by mere evaporation cubes or lozenges.†

Many other instances might be given of the insufficiency of figure or shape for the perfect delineation of permanent mineral characters.

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Specific

* Vid. IV. Pott, 49.

† Mem. Par. 1755, p. 540.

Specific Gravity is allowed to be one of the best external tests; but it frequently varies, by reason either of the different texture of the same species of mineral into whose interstices water cannot equally penetrate, or by reason of the greater proportion of some or other of the constituent parts, as is particularly observable in zeolytes, sparry or calcareous iron ore, and other fossils. Also, various substances specifically different, possess very nearly the same specific gravity.*

It now remains that we give an Account of the true method of studying Mineralogy, in doing which we are lead to speak of some excellent performances which have appeared in our own time; the *Sciagraphia Regni Mineralis* of Sir Torbern Bergman, Professor of Chemistry at Upsal, tended very much to the improvement of
Mineralogy,

* Vid. Kiiwan's Elem. of Min. Pref. viii. ix. x. xi.

Mineralogy. It may be considered as a master-piece of the kind. His classes are four. 1. Sales. 2. Terræ. 3. Bitumina. 4. Metalla. These, he observes, are the most natural divisions. “*Fossilia,*” says he, “*generatim quadruplicis sunt differentiæ vel enim salina, vel terrena, vel phlogistica, vel denique metallica indole gaudere reperiuntur. Hinc quatuor enascuntur Classés.**”

He has introduced some new terms into the science which seem very expressive, and which have given rise to a happy choice of names affixed to species. Thus among the Sales Neutrales, their nature is designed by their appellation.

What was commonly called vitriolated tartar, is named alkali vegetabile vitriolatum, which shews at once the component parts of the compound.

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* Bergm. Sciagr. Regn. Min. p. 20

The Glauber's salt is named alkali minerale vitriolatum. The use of such names is obvious to a Chemist. We immediately see that in the first example, the mineral is composed of the vegetable alkali united to the vitriolic acid; in the latter, it is the mineral alkali combined with the same acid. Amongst the saline substances with an earthy basis, we likewise find the nature of the fossil expressed by its name. Epsom salt is named magnesia vitriolata, and alum, argilla vitriola. Amongst those with a metallic basis, the union is equally clear: blue vitriol is named cuprum vitriolatum; white vitriol, zincum vitriolatum, &c. We are at first sight rather surpris'd to find the diamond arranged amongst the bitumina, or inflammable substances. Mr. Bergman proceeds on a fact published by M. Lavoisier in the Mem. de l'Acad. de Paris, and which has since been fully established. This precious
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stone, which has by the common consent of all mankind been held in general esteem, is now found to possess properties peculiar to itself. When exposed to the focus of a strong burning lens, it is entirely evaporated under the form of vapor.

The great genius of Newton never shone more conspicuous, than in the minute observations which he made on this singular gem. In the second book of Optics, part iii. prop. x. we have a curious investigation of the properties, which unctuous and sulphureous bodies have in reflecting and refracting the rays of light, the words of the proposition are: "If light be swifter in bodies than in vacuo, in proportion of the sines which measure the refraction of the bodies, the forces of the bodies to reflect and refract light, are very nearly proportional to the densities of the same bodies, excepting that unctuous and sulphureous

reous bodies refract more than others of the same density.

In the proof of this proposition, we are presented with a table, which is worthy the attention of every chemical philosopher, and as I do not know that it has ever been noticed in the works of Chemistry, I shall here take the liberty of offering it to the inspection of the reader. In doing this, it is but fair that I acknowledge my obligations to an ingenious friend, the Reverend Mr. *Stephenson*, Fellow of Clare Hall, who first pointed out to me the following passages.

TABLE

T A B L E.

The refracting Bodies.	The proportion of the Signs of Incidence and Refraction of yellow Light.	The Square of B. R. to which the refracting force of the Body is proportionate.	The density and specific Gravity of the Body.	The refractive power of the Body in respect of its density.
A Pseudo Topazius, being a natural pellucid brittle hairy Stone, of a Yellow Colour - - -	23 to 14	1,699	4,27	3979
Air - - -	3851 to 3850	0,00052	0,00125	4160
Glass of Antimony - - -	17 to 9	2,568	5,28	4864
A Selenitis - - -	61 to 41	1,213	2,252	5386
Glass Vulgar - - -	31 to 20	1,4025	2,58	5436
Crystal of the Rock - - -	25 to 16	1,445	2,65	5450
Island Crystal - - -	5 to 3	1,778	2,72	6536
Sal Gemmæ - - -	17 to 11	1,388	2,143	6477
Alume - - -	35 to 24	1,1267	1,714	6570
Borax - - -	22 to 15	1,1511	1,714	6716
Niter - - -	32 to 21	1,345	1,9	7079
Dantzick Vitriol - - -	103 to 200	1,295	1,715	7551
Oil of Vitriol - - -	10 to 7	1,041	1,7	6124
Rain Water - - -	529 to 396	0,7845	1,	7845
Gumm Arabic - - -	31 to 21	1,179	1,375	8574
Spirit of Wine well rectified - - }	100 to 73	0,8765	0,866	10121
Camphire - - -	3 to 2	1,25	0,996	12551
Oil Olive - - -	22 to 15	1,1511	0,913	12607
Lintseed Oil - - -	40 to 27	1,1948	0,932	12819
Spirit of Turpentine. - - -	25 to 17	1,1626	0,874	13222
Amber - - -	14 to 9	1,42	1,04	13654
A Diamond - - -	100 to 41	4,949	3,4	14556

“ The refraction of the air in this table, is determined by that of the atmosphere, observed by astronomers, for if light pass through many refracting substances or mediums, gradually

dually denser and denser, and terminated with parallel surfaces, the sum of all the refractions will be equal to the single refraction, which it would have suffered in passing immediately out of the first medium into the last. And this holds true, though the number of the refracting substances be increased to infinity, and the distances from one another as much decreased, so that the light may be refracted into every point of its passage, and by continual refractions, bent into a curve line. And therefore the whole refraction of light, in passing through the atmosphere, from the highest and rarest part thereof, down to the lowest and densest part, must be equal to the refraction, which it would suffer in passing at like obliquity out of a vacuum, immediately into air of equal density, with that in the lowest part of the atmosphere.

Now

Now by this table, the refractions of a Pseudo Topaz, a Selenitis, Rock Chryſtal, Iſland Chryſtal, Vulgar Glaſs, (that is, ſand melted together) and Glaſs of Antimony, which are terreſtrial ſtoney alcalizate Concretes, and *air, which probably ariſes from ſuch ſubſtances by fermentation*, though theſe be ſubſtances very different from one another in density, yet they have their refractive powers almoſt in the ſame proportion to one another, as their densities are, excepting, that the refraction of that ſtrange ſubſtance, Iſland Chryſtal, is a little bigger than the reſt: And particularly Air, which is 3,400 times rarer than the Pſeudo-Topaz, and 4,200 times rarer than Glaſs of antimony, has, notwithstanding its rarity, the ſame refractive power in reſpect of its density, which thoſe two very denſe ſubſtances have in reſpect of theirs, excepting ſo far, as thoſe two differ from one another.

Again, refraction of the Camphire, Oil Olive, Lintseed Oil, Spirit of Turpentine and Amber, which are *fat and sulphureous unctuous bodies, and a diamond, which probably is an unctuous substance coagulated*, have their refractive powers, in proportion to one another as their densities, without any considerable variation. But the refractive powers of these unctuous substances, is two or three times greater in respect of their densities, than the refractive powers of the former substances in respect of theirs."

For the remaining part of the observations, which are well worthy the attention of a Chemist, we must refer to the work itself, without which, the whole of the table here given, cannot be understood

The work of Mr. Kirwan has no rival. It possesses the singular advantage of combining the excellence of preceding writers with many new discoveries.

coveries. The author has availed himself of the labors of others, and labored much himself.

The *Sciagraphia Mineralis* of Mr. Bergman has been of great use to him, and Mr. Kirwan acknowledges that it was, " by the solidity of his judgment, the ingenuity and accuracy of his methods, and the multiplicity of his experiments, that Mineralogy was brought to that degree of perfection at which we at present behold it." The writings of Margraaf of Berlin, and the discoveries of Brandt, Swab, Gahn, and Scheele are all made subservient to this system. The classes of our author are the same as those of M. Bergman. 1. Earths and Stones. 2. Salts. 3. Inflammable Substances. 4. Metallic Substances. He takes the character of his Classes, Genera and Species, from the nature of their internal composition; but the varieties are described from their external appearance

pearance only. Thus among the Earths

CALCAREOUS GENUS,

Species I.

Calcareous earth, uncombined with any acid.

Species II.

Combined With the aerial acid.

Series I.

Transparent spars.

Series II.

Opake.

In this instance we see the Genus is first mentioned according to its chemical nature. The Species is likewise chemically described, together with such a description of the external qualities as can be of service to assist the Naturalist. Thus the first species is
said

said to be “ a stone of a grey colour, moderately hard, or rather soft, found near Bath ; it is mixed with calcareous earth combined with fixed air ; and hence it effervesces with acids, but at the same time it is soluble in water, to which it communicates the taste of lime ; and if this solution be mixed with sulphur it dissolves it, and forms a calcareous liver of sulphur, with the assistance of heat, whence it is plain that part of the calcareous earth is in an uncombined state.” Here we have a description of the appearance as it most commonly occurs, but a certain knowledge of the matter can only be gained by Chymical experiment. In the two species again we know, that they “ all effervesce with acids ; none give fire with steel ; and the chrySTALLIZED decrepitate when heated.” The most remarkable varieties of external appearances are comprehended under the two series of, 1. Transpa-
rent.

rent, 2. Opake. In the first series they are called Spars, and these are mentioned to be found in various forms, as rhombodial, hexangular, triangular, polyangular. Their specific gravity is likewise commonly noticed, and Mr. Kirwan is particularly minute in giving an exact chymical analysis of the mineral, wherever it can be done.

The science of Chymistry is indeed eminently conspicuous in this particular analysis, and has been carried to great extent: not only the common minerals, but even the precious stones have been analyzed by the indefatigable Mr. Bergman. We shall here subjoin an abridged view of one of the tables given by Mr. Kirwan, with some amendments from the second vol. of Bergm. Opusc, Chen.

TABLE

T A B L E III.

Of the proportion of ingredients in
Earths and Stones.

Calcareous Genus.

100 Parts.	Calcar.	Argill.	Silex.	Magn.	Water	Iron.
Calcareous Spar.	53	—	—	—	11	a
Gypsum -	32	—	—	—	38	b
Fluor -	57	—	—	—	—	c

a. And 34 Fixed Air. b. and 30 Vitriolic Acid. c. 43 Acid
and Water.

Siliceous Genus.

100 Parts.	Silex.	Argill.	Calcar.	Magn.	Iron.
Chrystal - -	93	6	1	—	—
Flint - - -	80	18	2	—	—
Jasper - -	75	20	—	—	5
Ruby - - -	39	40	mild 9	—	10
Hyacinth -	25	40	D ^o 20	—	13
Topaz - -	39	46	D ^o 8	—	6
Emerald - -	24	60	8	—	6
Sapphire -	35	58	5	—	2
Garnet - -	48	30	12	—	10

What has been said will give a
tolerable idea of the present improved
state of Mineralogy, and it must ap-
pear

pear sufficiently obvious, that there can be no comparison in the methods to be adopted for its attainment. A superficial dabler in the study of Nature, may amuse himself by collecting and arranging multitudes of Minerals, which may in reality be mere varieties of a few Species, whilst the more enquiring Naturalist will labour to attain real knowledge, and wish to possess those facts which lead him to an exact discrimination of the objects of his pursuit.

When a tolerable knowledge of Mineralogy is acquired, the philosophic Naturalist will receive great amusement from a variety of geological observations on the antiquity and origin of Mountains, their height, and the means of determining it by means of the Barometer; — their internal structure; — the nature of Volcanos and their productions, &c.

Those

Those who wish to make themselves more particularly acquainted with the Theories that have been published respecting the formation and structure of the World, will find great information and amusement from the "Lettres Physiques et Morales," par M. de Luc, where the Theories of Burnett, Whiston, Woodward, Leibnitz, Scheuchzer, l'Abbè Pluche, Le Catt, Telliamed, Lazzaro Moro and Buffon are detailed. Mr. Forster's Observations, the *Amœnitates Academicæ* of Linnæus, and several other Works, will likewise be found exceedingly useful on this and other branches of Natural History. We shall here cease our account of the method to be preferred in studying the inanimate parts of Matter, and proceed to treat of organized bodies, as they appear under the forms of Vegetable, or Animal Life.

P A R T II.

The Vegetable Kingdom.

IN studying the appearances of matter under the organised form of vegetables, many curious observations present themselves to the eye of a philosopher. Their structure, habit, propagation, and several other physiological questions, equally interesting and important, occur to the naturalist; whilst their number, diversity, and other peculiar circumstances, attract his attention. It is not our business in this place to indulge the speculations of enquiry, or descant on the beauties of this field of nature. We must content ourselves with such observations as may yield instruction to the uninformed,

formed, and teach them how to tread the splendid path of flowers. From the earliest period of time some attention seems to have been paid to the vegetable kingdom. The food of the rude inhabitants of every country is commonly derived from plants. The most barbarous nations are found to possess some knowledge of the use of vegetables. It is therefore to be presumed, that, long before history conveys intelligence, the study of mankind was particularly turned towards this part of the beauties of nature. We learn from Holy Writ, that Solomon was far advanced in the science of Botany. He is said to have written on the subject; but neither his writings, nor those of Anaxagoras, nor Pythagoras, have been handed down to us. Theophrastus, the disciple of Aristotle, in the third century before the Christian æra, published a work, entitled, “ The History of Plants,” which,

which, I believe, is the earliest legend that this subject boasts of. In it he treats of the origin, propagation, anatomy, and construction of vegetables; of vegetable life, and of vegetation. It was near four hundred years after this publication, that Dioscorides distinguished himself as an eminent botanist. Pliny, in the amplitude of his natural pursuits, glanced at the vegetable creation; but he does not appear to have entered deeply into the subject, and many ages elapsed before this branch of knowledge assumed the regular form of a science. At length the time arrived when the necessity of system became apparent. A serious attention convinced the botanists that the kinds and species, even of locality, were too numerous for the memory to retain without arrangement. The methods which were chosen are very different; and the young student will be surprized to find, that even at the present

sent day, philosophers are unacquainted with a system wholly unexceptionable. The method of arranging plants alphabetically was much followed, especially in local catalogues. Pauli, in his *Quadripartitum Botanicum*, published in 1639, has disposed them according to the *time of flowering*. Beller, in the *Hortus Eystettenfis*, 1640; and Dillenius, in the *Catalogus Giffensis*, 1719, have followed this method. Others have arranged them according to the *different places of their growth*, as the authors of the *Historia Lugdunensis*, in 1587; and some according to their virtues in medicine. Others who observed that many vegetables agreed with each other in certain particulars, have endeavoured to take these peculiarities as the leading character of their systems. Thus the harmony or proportion in the form and disposition of their roots, leaves, flowers, or fruit; the particular mode of growing, flowering,

ering, or foliation; has given rise to classes agreeable to such distinctions. Hence the division of trees into pomiferæ, nuciferæ, bacciferæ, pruniferæ, glandiferæ, &c. : of herbs into bulbosæ, filiquosæ, umbelliferæ, verticillatæ, papilionacæ, &c. These are classes or orders which Nature herself has instituted, and it is the grand desideratum of botany to reduce, and connect all vegetables according to such a *natural method*. In this point, however, the most sanguine endeavors of the naturalists have hitherto proved ineffectual. John and Caspar Bauchine, in the last century, pursued this plan. Gerard and Parkinson followed their example, but as they established no precise definitions to their classes, and were not accurate in the minuter parts of their system, their classification proved exceedingly imperfect.

Conrade Gesner, a distinguished naturalist, who died in 1565, seems to have

have been the first who pointed out the method of classing plants from the flower, or fruit; but he did not pursue the idea so as to fashion it into a system. Cæsalpinus, physician to Pope Clement VIII. was the first author who arranged vegetables in a true systematic manner. In his *Libri de Plantis*, published in 1583, he endeavors to establish the character principally *from the fruit*, but a great length of time elapsed before his plan was wrought into a system. Morison and Ray published their separate systems nearly together, in which their characters are principally taken from the fruit. Several authors of eminence have attempted to perfect their labors, as Knaut in Germany, Paul Herman and Boerhaave in Holland, and Dillenius, professor at Oxford. The flower was first taken as the foundation of the classical character by Rivini, at Leipzig, in 1690. The regularity and irregularity, as

H

well

well as the number of the *petals*, have been made the principal distinction. Tournefort, in 1694, carried this method to very great perfection. He forms the character of his classes from the figure of the flower, and establishes his orders or subdivisions on the different situation of the fruit, whether above or below the empalement or receptacle. Ruppius, in 1718, likewise took the flower as the foundation of his method. Several attempts have been made to arrange vegetables according to what are called natural classes; the foundations of which comprehend a variety of characters arising from a combination and agreement in the *habit* of plants, and their *harmony* in the essential parts of fructification, as we have before noticed. Van Royen, late professor at Leyden, is author of the most elegant system hitherto published on this plan. It is exhibited in the *Prodromus Floræ Leydenensis*,

sis, 1740, and together with that of Cæfalpinus, Tournefort, and Ray, comprises the whole of the Systematists with which my late worthy friend and præceptor, Dr. Hope, thought it necessary for his students to be acquainted, previous to their entering upon the Linnæan system.*

Haller has given a method resembling that of Van Royen, which is brought to great perfection in his *Enumeratio Stirpium Helvetiæ*, 1742. *Hortus Gottingensis*, 1753, and *Historia Stirpium Helvetiæ*, 3 tom. fol. 1768. Gmelin, in the *Flora Sibirica*, 1747, followed nearly the same plan; and L. Gerard, in his *Flora Gallo-Provincialis*, Paris, 1761, preserves very nearly the natural generical characters of Linnæus, taking the orders of a natu-

* Vide Dr. Hope's useful little work, entitled, *Genera Plantarum in Usus Academicos*. *Edinb.* 1780.

ral method, constructed by B. Jussieu, for his classes.

Among the systematic writers, Linnæus has enumerated no less than twenty-eight; but as it would be tedious to pursue this part of our subject any farther, we shall proceed to detail that system which is now the most universally received and admired.

Charles Von Linnè, or (as he was commonly called) Linnæus, was the son of a Swedish Divine, and born at Roeskult, in the province of Smaland, in Sweden. There is something botanic in the very name of Linnæus; for the ancestors of this family are said to have taken the surnames of Linnæus, Lindelius, and Tiliander, from a large lime-tree, or linden-tree, yet standing on the farm where this naturalist was born. Such an origin of surnames is not uncommon in Sweden. After struggling with the difficulties of adverse fortune, this
great

great man arrived at honor and independence. He was made Professor of Physic and Botany in the University of Upsal, Physician to his Sovereign, and Knight of the Order of the Polar Star. In 1757, he was ennobled, and on the resignation of his office had his pension doubled, and a liberal donation of landed property settled on him and his family. He died January 11, 1778, aged seventy years and eight months. It is, however, foreign to our purpose to pursue the biography of any naturalist. The distinguished eminence of Linnæus can alone excuse the present digression.* We shall therefore return
to

* On the death of Linnæus a general mourning took place at Upsal, and his funeral procession was attended by the whole University, as well professors as students; and the pall supported by sixteen Doctors of Physic, all of whom had been his pupils. The King of Sweden paid the highest honors to his memory, He ordered a medal to be struck, of which one side exhibits Linnæus bust and name, and the other Cybele,
in

to give a sketch of the botanic system of this great man.

Linnaeus

in a dejected attitude, holding in her left hand a key, and surrounded with animals and growing plants, with this legend—*Deam lucus angit amissi*,—and beneath—*Post Obitum Upsaliae, die x Jan. MDCCLXXVII, Rege jubente.*—The King likewise was present at the meeting of the Royal Academy of Sciences at Stockholm, when Linnaeus's commemoration was held; and in his Speech from the Throne to the Assembly of States, he paid a tribute to this great man's memory, by lamenting the loss of Sweden in his death. The benevolent and distinguished Professor of Botany at Edinburgh, at the opening of his Lectures in 1778, pronounced an eulogium in honor of Linnaeus, and perpetuated, by an elegant compliment, the fame of this naturalist, together with his own name. He laid the foundation stone of a monument in the Botanic Garden, consisting of a vase supported on a pedestal, with this inscription,

Linnaeo
posuit
J. Hope.

This very worthy man, whose death is sincerely lamented by all who knew him, has left behind him another instance of his peculiar attention to merit, in whatever rank of society he found

Linnaeus very early attempted a natural method of arrangement ; but he soon found that too many links are wanting in the chain to render it the readiest guide to botanical science. He only reduced the genera into orders, but did not venture to form the classific part of a system on that plan. He made an attempt to fix the *calyx*, or *cup* of the flower in plants, as a source of arrangement, in which he seems to have followed Professor Magnol, of Mont-

found it. In a shady and retired part of the same garden is raised a monument to the memory of a faithful servant, who discharged the duties of his office as a Gardener with fidelity and credit. The man, who, in the midst of various occupations which science and medical practice occasion, could give attention to the perpetuity of merit, will not, it is hoped, himself soon sink into oblivion. A select publication of such manuscripts as the Professor has left behind, could not fail of being a valuable acquisition to the botanic world. The progress which he had made in a natural method will prove to him

“ Monumentum cere perennius.”

Montpelier, who published in 1720.* But he soon rejected all these methods, and was the first who constituted the stamina and pistils, as the basis of an artificial method of arranging plants. He was led to this by considering the great importance of these parts in vegetation. He maintained, that they alone are essential to fructification, since all other parts, except the *anthera* and *stigma*, are wanting in some flowers. The present philosophy of botany regards the former as the male, and the latter as the female organs of generation in plants. From this distinction of the sexes of vegetables, the arrangement of Linnæus is known by the name of the Sexual System. It consists of twenty-four classes, and their characters are established upon the number, situation, or arrangement of the stamina, or male organs. The orders

* Vide Pulteney's View of Linnæus's Writings, p. 116.

ders or subdivisions of these classes are, as far as possible, drawn from a similar number, situation, or arrangement of the pistils, or female organs. In the first twenty classes are contained such flowers as have the stamina and pistils both within the same cup or petals, or standing on the same receptacle where these are wanting. The author calls them hermaphrodite: as according to his doctrine there are both male and female parts in the same flower.

The first ten classes proceed in an uninterrupted series, from Monandria to Decandria; the plants of each having as many stamina as the title expresses; thus, 1. Monandria, Stamen unicum in flore hermaphrodito. 2. Diandria, Stamina duo in flore hermaphrodito. 3. Triandria, Stamina tria in flore hermaphrodito, &c.

The eleventh class is Dodecandria, Stamina duodecim in flore hermaphrodito.

dito. For it is very remarkable, that no plants yet discovered have exactly eleven stamina.

The twelfth, Icosandria, containing such plants as have about twenty stamina, or more, arising from the *calyx*, or *corolla*, and not from the receptacle.

The thirteenth, Polyandria, may have the same number of stamina as the former, but they arise from the *receptacle*, and are commonly very numerous.

The fourteenth class, Didynamia, comprehends such plants as have four stamina, two long, and two short. This includes vegetables of a very particular description, the essential character of which does not consist in the number, but size and peculiar form of the stamina, two of which are uniformly shorter than the other. The corolla is irregularly shaped, and there is only one pistil.

The

The fifteenth, *Tetradynamia*, includes plants with six stamina, four of which are longer than the other two.

The sixteenth, *Monadelphia*. In this the stamina are not distinct at the base, but united into one body.

The seventeenth, *Diadelphia*, in which the stamina are united at the base into two bodies.

The eighteenth, *Polyadelphia*. In this the stamina are united at the base into several bodies.

The nineteenth, *Syngenesia*, in which the antheræ unite together so as to form a tube or cylinder, through which the pistil commonly ascends.

The twentieth, *Gynandria*, in which the stamina proceed from the pistil, and not the receptacle.

The twenty-first, *Monoecia*; such as have separate male and female flowers on the same plant.

The twenty-second, Dioecia such as have separate male and female flowers on separate plants.

The twenty-third, Polygamia. In this class, besides the hermaphrodite flowers, there are, others, either male or female, in the same plant.

The twenty-fourth, Cryptogamia. In which are contained those plants, the mode and organs of whose fructification are not yet sufficiently ascertained. They have been called imperfect plants, and it may justly be said of them, "*Parvitate oculos nostros subterfugiunt.*"*

The

* It was rather from conjecture than proofs, that Linnæus instituted the class of Cryptogamia. He reasoned from analogy, and late writers have given proof of the truth of his supposition. Some time ago Micheli asserted, that he had observed the real stamina and pistilla in Mosses; but his observations were neglected, and scarcely credited, 'till the accurate Dr. Hedwig, of Leipzig, published his history of Mosses in 1782, in which he has demonstrated the parts of fructification of several Mosses, and illustrated the structure and œconomy of
of

The orders of the system are for the most part taken from the number of the pistils, or female parts. Thus in the first thirteen classes, in which the classical character depends uninterruptedly on the number of stamina, the orders depend likewise on the number of pistils; but when situation or different arrangement takes place, they are most commonly founded on other distinctions. Thus the Didynamia has the two

of these minute plants in a very complete manner. He proves that the capsula of Dillenius, (the anthera of Linnæus) which both those authors considered as producing the impregnated pollen, is in fact the fruit, and the powder which it contains the seed; and that the male flowers are what Linnæus and others took for the female. This was suspected by the celebrated Schreber, and the opinion is now adopted by all scientific botanists. Dr. Hedwig has prosecuted his enquiries in other orders of the Cryptogamia; and in a prize dissertation, published at Petersburg, which has not yet reached this kingdom, he has illustrated the fructification of the Filices, Algæ, Musci, and Fungi, in thirty-seven plates. For an Abstract of his Discoveries, vide Smith's Translation of Linnæus's Dissertation on the Sexes of Plants, p. 59, 60, 61, 62.

two orders of Gymnospermia and Angiospermia: the former having four naked seeds, and the latter having the seeds inclosed in a seed vessel. In the Tetradynamia, the two orders of Sili-culosa and Siliquosa are taken from the size and shape of the pod or shale; in the former of which it is short, and in the latter long. In the classes of Monadelphia, Diadelphia, and Polyadelphia, the orders are formed from the number of the stamina. In the Syngenesia class there are two general subdivisions or orders, Polygamia and Monogamia; the first of which is divided into five lesser divisions, as Polygamia, Æqualis, Superflua, Frustranea, Neceffaria, Segregata. The differences here arise from the different structure or sex of the Floscules, constituting the whole flower.

In the Gynandria, the orders are taken from the number of the stamina,
as

as in the sixteenth, seventeenth, and eighteenth classes.

In the Monoecia and Dioecia classes, the characters of the orders are drawn from the characters of the foregoing parts of the system as far as to the Monoecia class itself; the first order of which contains Monandrous, and the last order of the *Diocoeia* Gynandrous plants.

The orders of the Polygamia contain the Monoecious, Dioecious, or Trioecious plants. The orders of the Cryptogamia class are Filices, Musci, Algæ, and Fungi.

It will be unnecessary to pursue this system any farther. From what has been said, a general idea may be formed of its principle; and as it is now almost universally received, we may venture to recommend it to the serious attention of those who wish to make any progress in the science of Botany. The great difficulty of this study consists in acquiring the various terms which

which serve for the description of the different parts of plants. It is therefore necessary that the young student be furnished with some guide on this subject. The most useful works with which I am acquainted are Lee's Botany, and the Elements of Botany, by Mr. Rose, an ingenious Apothecary, who has given a translation of Linnæus's principal Observations in support of the Sexual System. From these books alone, considerable progress may be made in Botany; but it is from the writings of Linnæus only that we can derive a full and complete knowledge of the vegetable creation. His Genera and Species Plantarum, together with the Supplement published by Young Linnæus, are indispensably necessary to the Botanist.* The Philosophia Botanica is a work

* These works are lately translated into English by a Society at Litchfield; but the performance (however laudable the attempt) falls short of the original, and serves to convince
us,

work of great utility, and together with a little Essay, entitled, " A Dissertation on the Sexes of Plants," translated from the Latin of Linnæus by my worthy friend Mr. Smith, one of the original members of this Society, forms a very happy illustration of the doctrine on which our author founds his system. The Botanic Letters of Rousseau, lately translated, with additions, by Professor Martin, of Cambridge, will afford amusement and instruction to the young Botanist, whilst the plates which have been published by a variety of authors, and executed by many eminent artists, will have the happy effect of conveying entertainment and improvement. The first botanic plates of which I have received any account are those of Gesner, which, though on

us, that no real progress can be made in Botany, or, perhaps any of the sciences, without a tolerable knowledge of the Latin Tongue.

K

wood,

wood, were very useful in their day, as well as those of Rudbeck, Ferrarius, Dordartius, and Rhædius. The first copper-plates of plants were published by Columna, which, together with those of Rivinus, Dillenius, Sir Hans Sloane, and Sir John Hill, form very useful additions to the Botanic library. The latter has confined his delineations to the English plants; but his work is far surpassed by the very elegant and splendid plates of Mr. Curtis, an apothecary in London, whose performance is an honor to the age which produced it. The learned President of the Royal Society, Sir Joseph Banks, who is justly esteemed and distinguished as the most eminent naturalist in this or any other country, is completing a set of plates, which for utility and elegance surpass every thing of the kind. They present to the Botanist well-finished representations of such plants as he may never have an opportunity of beholding.

ing. The elegant engravings in Mr. Forster's Observations, a work which we have already recommended, ought likewise to be mentioned as worthy the attention of those naturalists who are desirous of being acquainted with the curious productions of the vegetable world in the South Seas.

In such an extensive field as that of Botany, it often happens that the genius or particular views of one man incline him to cultivate with peculiar ardor a particular part. In such case it may be of use to know, that several authors have distinguished themselves in respective departments. Thus Morison and Artedi excel in their accounts of the Umbelliferous plants. Ray, Montius, Scheuchzer, and Michelius, are the esteemed writers on the Gramina; Dillenius on the Mosses; and both the latter likewise on the Fungi.

The anatomy and physiology of plants have been accurately treated by

Malpighi, Grew, Hales, Gefner, Feldman, and Ludwigius. The virtues of plants have been copiously treated by many writers on the *Materia Medica*. No subject, indeed, has been more discussed, and worse treated. The wildest conjectures have been assumed as facts, and qualities the most imaginary have been attributed to vegetables, and their various parts. It has been the business of medicine in the present age to consign to oblivion many plants formerly supposed to have specific powers. To those who may occasionally desire to turn their attention to this matter, I would recommend Dr. Alston's Lectures on the *Materia Medica*, published by Dr. Hope, which, with Lewis's Dispensatory, form a system of vegetable medicine, sufficiently accurate for the purposes of common enquiry. The work of Geoffroy was formerly in great repute, and does still deserve attention, for the chemical analysis which he gives

gives (however imperfect) of several plants. In the systems of *Materia Medica* by Murray, and Bergius, Professor at Stockholm, we have arrangements according to the Linnæan method, highly useful to medical men. And the *Materia Medica* of Dr. Cullen is perhaps the most philosophical view that was ever given of this subject. The *Amœnitates Academicæ*, which consist of a Collection of *Theses* in 7 volumes, in 8vo. published under the inspection of Linnæus, contain many valuable observations on every branch of Natural History. Dr. Lewis's *Commerc. Technic. or Philosophical View of the Arts*, is a work which deserves to be mentioned in this place, as highly useful to the Naturalist and Philosopher. The plants of particular countries have likewise their particular historians. Those of Lapland have been explored by Linnæus; of Prussia, by Læfilius;
of

of Paris, by Vaillant; England, by Ray, Sir John Hill, Hudson, Curtis, &c. and of Scotland, by Lightfoot.*

We shall here close our account of the method of studying the vegetable kingdom; and we trust, that what has been said will be sufficient to excite the attention of the young student, as well as to afford him some instruction.

We have endeavoured to give the outlines of this branch of study: for as general information must necessarily be premised before particular knowledge can be attained, we trust, that it will appear no small progress to have acquired, at one view, some acquaintance with the various authors of an enlarged and comprehensive subject.

* Vide Linn. Phil. Botan.

P A R T III.

The Animal Kingdom.

WHEN we take a view of the number of animals which exist in every part of our earth, we shall be ready to acknowledge, that it must be matter of real difficulty to attain a tolerable acquaintance with them. The appearances of nature are not immutable. Many of her external forms are fugitive, and it is only by serious attention, and minute investigation, that we can fix upon points which she has characterized indelible.

When such characteristic marks are once discovered, we may proceed to system, and attempt the classification even of infinitude. Multiplicity will no longer constitute difficulty. It is by method
that

that we facilitate study, and in matters of natural science, we are at liberty to borrow artificial aid. I shall therefore mention some of the principal methods which have been offered to the public, and conclude with an enumeration of the principal authors in each branch of the science.

Aristotle was probably the first who ever thought of arrangement in this subject. He established only general and simple divisions; but his excellent reflections on the external and internal organs of animals, laid a foundation upon which the classifications of the first methodical naturalists, as Gesner, Aldrovandus, Johnston, Charleton, Ray, &c. have been founded.* A great number of other naturalists, whom

* In 1693, Mr. Ray published his *Synopsis Method. Animalium, Quadrupedum, & Serpentinum Generis*. His two general divisions are into *Quadrup. ungulata*, or hoofed; and *Quadrup. unguilata*, clawed or digitated.

whom we shall have occasion to mention hereafter, have enriched Natural History by their observations: but it was left to the sagacity and penetration of Linnæus to fix upon a method of characterizing all living bodies. His system is undoubtedly liable to many exceptions; but it is easier to find fault than to amend. In the year 1735, Linnæus first published the system, of which we shall attempt some account. After taking a philosophical view of the subject in general, he proceeds, in Vol. I. of the *Systema Naturæ*, to the establishment of the classical characters, from the different internal structure of animals. By this natural division all the animal kingdom naturally divides itself into six classes, as follow:

Animals with the heart furnished with

Two ventricles and	}	Viviparous.	Mammalia.
auricles:			
Blood warm and red	}	Oviparous.	Birds.
		L	One

One ventricle and auricle :	} Respiration } voluntary. }	Amphibia.
Blood cold and red.	Breathing by gills.	Fishes.
One ventricle without auricle :	} Antennated. Insects. Tentaculated. Worms.	
Sanies, cold and colourless.		

To this account of the internal structure the author adds all the differences arising from the lungs or other organs of respiration, from the maxillæ, jaws or mandibles, organs of generation or sensation; the teguments, or outward covering, and the fulcra, or legs, wings, &c. At the head of each class is given a concise description of the classical character, including an explanation of the terms belonging to the class. We have likewise a general enumeration of the best authors on each; a part of the work exceedingly useful to students, and from which we shall occasionally borrow, in our view of the method of studying this part of the creation.

CLASS

CLASS I. MAMMALIA.

Comprehends all those animals which we call quadrupeds, (except the lizard genus, or reptiles pedati, as they are called) and likewise the cetaceous order, or whales, cachalots, and porpoisses. Several authors have dissented from this arrangement of whales with quadrupeds, and the author had separated them in the first edition of his *Systema Naturæ*; but upon reflection he thought himself justified in such a classification. The striking particulars in which they differ from fishes, as the structure of the heart, having lungs for respiration, moveable eyelids, being viviparous, and furnished with teats, all incline him to refer them to this class. The single circumstance of living in the same element is therefore overlooked.

One ventricle and auricle :	} Respiration } voluntary. }	Amphibia.
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The mammalia are divided into seven orders, which are principally taken from the difference in the number, situation, and form of the three kinds of teeth with which animals are endued, viz. the *primores* or *incisores*, called the fore-teeth or cutting-teeth; the *laniarii* or *canini*, dog teeth, canine, or lacerating teeth; and the *molares*, grinders, or double teeth. Our author likewise takes into consideration the feet, as will appear from the following view of the orders.

I. Digitated.

Fore teeth, four.	Canine	
single,	-	Primates. 1.
Fore teeth, none	-	Bruta, 2.
Fore teeth, 6, 2, 10 conical.		
Canine single	-	Feræ. 3.
Fore teeth, two.	Canine	
none	-	Glires. 4.

II. Hoofed.

No fore teeth above	Pecora. 5.
Fore teeth above and below	Belluæ. 6.

III. De-

III. Destitute of Hoofs or Claws, Teeth, various in the diffe-

rent genera - Cete. 7.

We shall here detail the characters as they stand at the head of each order.

I. Primates. Animals furnished with fore teeth, or cutting teeth: four above; parallel. Two pectoral teats.

II. Bruta. No fore teeth.

III. Feræ. Six sharp fore teeth in the upper jaw. One canine tooth on each side.*

IV. Glires. Two fore teeth in each jaw, close together; but remote from the grinders. No canine teeth.

V. Pecora. No fore teeth in the upper jaw; six or eight in the lower jaw very remote from the grinders. Hoofed feet; inguinal teats.

VI. Bel-

* There are exceptions to this order, some of the genera have above six teeth. The Didelphis has 17, the Sorex 19, and the Erinaceous 20.

VI. Bellua. Fore teeth truncated. Hoofed feet.

VII. Cete. Breathing apertures on the head. Pectoral fins. Tail placed horizontally. No claws.

Many objections have been made to this system of classification. It is said to be arbitrary and unnatural. Animals are classed together whose figure and habits are distinctly different. It is therefore alledged that the method is imperfect; and the fact may be admitted without any detraction of its real merits. For although the pride and assumed consequence of man may be offended when he beholds himself ranked with the brute creation, and finds that even the internal structure of such a hideous monster as the bat resembles the real formation of his frame; yet on minute enquiry he will have cause to admire the simplicity and magnitude of that system which shews him his real station, and makes him

him acquainted with the wondrous extent of his own empire. Linnæus has placed man at the head of the Primates, and given him the Grecian dictate, " Know thyself," as his motto. By a concise and elegant comment he endeavors to shew, that however near his alliance to the mere animal, yet by the culture of his faculties, it is in his power to prove himself an *intelligent and moral being*.

The nature of our plan will not allow us to enter into a detail of the genera or species; we shall therefore continue our view of the system, by an examination of the orders of the remaining classes.

CLASS II. AVES. BIRDS.

Linnæus has divided these into six orders, the distinction of which are chiefly taken from the beak; but it
has

has been necessary in some genera to take in the tongue, nares, or nostrils, and likewise the feet, and other parts.

I. Accipitres. Rapacious. Birds having the upper mandible of the beak furnished on each side with an angular process.

II. Picæ. Pies. Birds having the beak rather compressed on the sides, and convex on the upper part.

III. Anseres. Web-footed. These have a beak somewhat obtuse, and covered with a thin skin; at the base underneath gibbous, and wide at the end; the *faux*, or edges of the base, denticulated; the feet palmated, or webbed, and formed for swimming.

IV. Grallæ. Waders. These have the beak subcylindrical, and somewhat obtuse; the tongue entire, and fleshy; the thighs naked for some space above the knees.

V. Gal-

V. Gallinæ. Gallinacious. Birds having the upper mandible convex, or arched, and receiving the edges of the lower nostrils, half covered by means of a convex membrane, rather cartilaginous; the rectrices, or tail feathers, more than twelve; the feet cloyen, but the toes connected by a membrane as far as the first joint.

VI. Passeres. Passerine. These have a conical acuminate beak; the nostrils ovated, open, and naked.

CLASS III. AMPHIBIA.

All the animals of this class have not the power of living either in air or water; but they have the singular property of suspending the function of respiration, and can perform it in a more arbitrary manner than other animals.

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This class is divided into four orders :

I. Reptiles pedati. Reptiles. Amphibious animals, which breathe through the mouth by lungs only; they are furnished with four feet.

II. Serpentes apodes. Serpents. Amphibious animals, breathing through the mouth by means of lungs only. They are destitute of feet, fins, and ears.*

III. Meantes. Gliders. These animals breathe by means of gills and lungs,

* Perhaps this last assertion is not fully proved.—Fishes were formerly supposed to be destitute of the organs of hearing; but several years ago Placentini found some bones in the head of a pike which had the appearance of those organs. Klein improved upon this hint in his History of Fish, &c. Vide Phil. Transf. vol. ix. p. 114. The learned Professor Camper described the organs very fully in the Memoir. de Mathem. & Phy. Roy. Acad. Sc. Paris. Since which time Mr. John Hunter and Dr. Monro have demonstrated them in a great variety of species. The probability, therefore, seems to be, that serpents may have the organs of hearing, though hitherto undiscovered.

lungs, and are furnished with arms and claws.

IV. Nantes pinnati. Breathing fishes. These respire arbitrarily by means of gills and lungs. The rays of the fins are cartilaginous.

CLASS IV. PISCES. FISHES.

In the first edition of the *Systēma Naturæ*, Linnæus followed the method of his friend Artedi, whose *Ichthyology* was published in 1738, in Holland. This method was established on the structure or situation of the tails in the cetaceous order, and on the difference in the gills, and rays of the fins in the other orders, whether cartilaginous or bony; but (as we have already seen) the cetaceous order is now placed among the *Mammalia*, and the *Nantes Pinnati* referred to the *Amphibia*. In the two last editions our au-

thor forms four orders of the bony fishes, (which respire by means of gills only) and these he has taken from the situation or absence of the *ventral* fins. He compares these to the feet of other animals, and their situation is denoted with reference to the pectoral fins. The orders are,

I. Apodes. Fishes destitute of ventral fins.

II. Jugulares. Those which have the ventral fins placed before the pectoral.

III. Thoracici. Fishes having the ventral fins placed underneath the pectoral fins.

IV. Abdominales. These have the ventral fins placed behind the pectoral, on the abdomen. Some authors, as Artedi and Gronovius have attempted to distinguish the species by the number of the rays in the fins ; but the variation is too great to establish a sufficient character. The specific characters

ters are therefore, at present, taken from a variety of particulars, as the number of rays in the fins, the form of the tail, the cirrhi, or beard at the mouth, the length of the jaw, and the spots and lines on the body, &c.

CLASS V. INSECTA, INSECTS.

A great number of authors appeared before Linnæus on this subject; but he was confessedly the first who determined the genera of insects, and assigned them their proper characters. He has arranged them under seven orders;

I. Coleoptera. Insects having the wings covered with two crustaceous cases, divided by a longitudinal suture.

II. Hemiptera. Half-winged insects, which have the shells or cases semi-crustaceous, not divided by a straight

straight future, but incumbent on each other in the margin. The beak is curved inwards.

III. Lepidoptera. These have four wings, imbricated, or cloathed with fine scales, or feathers; tongue spiral, and coiled up; body hairy.

IV. Neuroptera. Insects with four naked transparent, or reticulated wings; the tail in most kinds without a sting.

V. Hymenoptera. These have four membranaceous wings, except some few species, which are destitute of wings. The females have the tail armed with a sting.

VI. Diptera. Insects with two wings, having also a balance or club behind each wing.

VII. Aptera. Insects without wings in either sex.

In studying this, as in every other part of Zoology, it is necessary to acquire a certain number of terms, without

without which no real proficiency can be made in the science. The genera of this class are characterized from certain parts of the animals, some of which have technical names, as the antennæ, or feelers; elytra, or outward cases; rostra, or mouth, &c. The head, thorax, tail, and other parts, are likewise occasionally used to assist in forming the character. The species of each of the orders are very numerous.

CLASS VI. VERMES.

We are now arrived at the last class in the System of Nature, which we are to consider as divided by our author into five orders. Linnæus has followed the method of Peysonel, Jussieu, and others, by introducing the coral and corallines into the animal kingdom, under the names of Lithopyta and Zoo-

Zoophyta. We shall likewise find the study of a very splendid part of Natural History presenting itself to our view, in the examination of the orders of this class. Conchology, or the study of shells, has long attracted the attention of Naturalists; and disputes have arisen respecting the proper method of studying the subject. The shells themselves, as mere coverings, or parts of living animals, cannot certainly demand our primary attention in a system of Zoology. The animals as one whole fall under our consideration, and accordingly Linnæus has made Conchology a branch of Zoology, and not of Mineralogy.

The characters of the orders of this class are very various.

I. Intestina. Animals simple, naked, destitute of limbs.

II. Mollusca. Animals simple, naked, not included in a shell, but furnished with limbs.

III. Te-

III. Testacea. These are generally of the foregoing order, but included in a shell.

This order comprehends the whole tribe of shells, consisting of thirty-six genera, and above eight hundred species, disposed according to a new method. The three first genera are called Multivalves; the next fourteen Bivalves; and the remainder Univalves.

IV. Lithophyta. These animals are composite. They are affixed to, and fabricate a fixed calcareous base, known by the name of coral.

V. Zoophyta. These are likewise called composite animals, and said to resemble a flower, and to spring from a vegetating stem.

Observations are yet wanting to ascertain the two last orders with precision. It is confessedly a matter of the greatest difficulty to draw the line of separation between the three kingdoms. The gradations of organized
N bodies

bodies are such as obstruct precise definition. Animals may exist whose principle of life resides in a structure of parts resembling the organization of vegetables, as is said to happen in the order Zoophyta; and it is not impossible to conceive that the real living parts of an animal may present themselves to our view in a form resembling that of a vegetable; but it is hardly possible to imagine, nay, it is dissonant to reason, to affirm, that the principle of life can exist in unorganized matter.

The Polype is evidently an animal bearing no resemblance to a plant; and probably future attention and experience to this order may inform us, that all the animals hitherto known under the name of Zoophytes, are properly referable to some other class or order. The whole order consists, according to Linnæus, of fourteen genera, of which nine are fixed, and the rest

rest locomotive; amongst the former are reckoned the Isis, or Red Coral, Sea Fan, Alcyonium, Sponge, Coralines, &c. Among the latter the Polype, Sea Pens, Tænia, Furia, and the Microscopical Animalcula. This view of the genera will be sufficient to shew the great defect of the order itself. For the greater part of the microscopical animalcula, or Animalcules des Infusions, as they are called, have been shewn by the Abbé Spallanzani, and others, to be distinct animals, not always of the class of Vermes. Some, indeed, have a very singular appearance; but I believe none of them are Zoophytes. In the same manner objections may be made to the order of Lithophyta. These animals have been supposed to connect the animal and mineral kingdoms; and it must be confessed, that they appear the last link in the chain of organized matter: but it appears to

me, that Naturalists have taken a superficial view of the matter of fact, and described as Lithophytes, substances which are in reality nothing more than the nests of real animals.

The genera of this order are four: the Tubiporæ, or red tubular coral; Madreporæ, or brain stones; Millepores, and Cellepores. In each of these kinds we observe certain pores or cells, apparently the receptacles or habitations of distinct animals. The assemblage which we view is not therefore to be considered as an animal, but rather as the fabrication of many animals, in the same manner as a shell is the work of a single animal. The coral, in my opinion, properly speaking, is no more a Lithophyte than any of the species in the order Testacea. It must, however, be confessed, that this subject is at present involved in great obscurity.

But

But to return: the generical distinctions of the class of Vermes are taken from a variety of particulars which deserve our attention. In the Intestina the genera are characterized almost solely from the diversity of the body of the animal. In the Mollusca, from the body and feelers, called *Tentacula*, and from other parts.

In the Testacea, the included animal, the general differences among the shells themselves, and principally the *cardo*, or hinge in the bivalves, together with the *aperture* in the univalves, furnish the general character.

In the Lithophyta the inhabitant animal is considered with the form of the coral itself: a proof of Linnaeus's opinion of the real nature of these animals. He considers the whole as the fabrications of different animals, and not as one whole animal itself. Have subsequent naturalists entertained the same ideas?

In

In the Zoophyta again the animal and the different forms of its fabrications lay a foundation for the generic notes.

The authors in Zoology are numerous and valuable. Gefner, Aldrovandus, and Johnston, are reckoned amongst the early writers on the Mammalia; and we have already mentioned our own countryman, Mr. Ray, as the predecessor of Linnæus. Many objections (we likewise observed) have been made to the general system of the latter: we shall, therefore, in this place take a view of the authors who have distinguished themselves in the various departments of this combined subject. In 1731, Mr. Klein published his *Quadrup. Dispositio Brevisque Hist. Nat.*—In his first order he has improved upon Ray's method; but in the second, the idea of a natural method seems to have forsaken

forfaken him; as he has combined animals which Nature feems to have referred to diftinct claffes: the camel is placed with the floth, the mole with the bat, and the glutton with apes. In 1756, M. Briffon propofed a method of claffing quadrupeds according to the number or defect of their teeth, beginning with the toothlefs, as the ant-eater, and ending with thofe that have the moft, as the opofum.

On the fubject of quadrupeds, we muft not omit to mention the Count de Buffon, whofe writings in various branches of Natural Hiftory and Philofophy deferve the attention of the naturalift. It is not, however, with a view to eftablifh the utility of fystem that we mention this author; he has attempted to reject all fystem, particularly in the ftudy of quadrupeds, whofe numbers are fo few as to give fome countenance to his opinion; but

but although we are unable to subscribe to his sentiments in this, and many other particulars, yet the elegance of his diction, and boldness of his thoughts, give such an air of novelty and genius to his works, as is rarely to be met with in subjects of Natural History, and must always recommend them to the perusal of the curious. His description of animals is generally beautifully just, and truly philosophic. In some instances we have the appearance of prejudice, but it is the prejudice of a philosopher.

Mr. Pennant, the English Linnæus, has given a system of quadrupeds, which is held in high esteem, and by many preferred to that of Linnæus. He follows Ray's method of hoofed or digitated; and, like M. Klein, makes separate genera of the rhinoceros, hippotamus, tapiir, and musk. The apes are placed according to Ray,
and

and followed by the maucaucos. In the arrangement of carnivorous animals he follows Linnæus, omitting the seal, mole, shrew, and hedgehog. The three last are joined to the herbivorous or frugivorous of Mr. Ray. The fourth section of digitated quadrupeds comprehends those which are entirely destitute of cutting teeth, as the sloth and armadillo. The fifth section comprizes those which have no teeth, as the manis and ant-eater. Our author has likewise added the divisions of pinnated and winged quadrupeds. Under the first are comprehended the walrus, seals, and the manati. These, he observes, appear the links between the quadrupeds and cetaceous animals. The bats are the winged quadrupeds, and seem to connect the class of birds.

The class of aves has attracted the attention of many distinguished naturalists. In 1755, Gesner, and 1557,
O Bel-

Bellonius, published upon this subject. Linnæus files them " Patres
" Artis."

In 1599, Aldrovandus, and 1648, Margraave, made additions to the science. In 1676, Mr. Willughby, an Englishman, published his Ornithology; which continues to hold a place in every naturalist's library. He was succeeded by Mr. Ray, in 1713; and in 1726, the study of this class was enriched with tolerable plates by Marfiglius. But these were excelled by Frischius, in 1734. In 1731, Albinus and Catesby employed themselves on this subject. And in 1745, Mr. Edwards published his Ornithology, embellished with very elegant plates, In 1746, Linnæus first gave the outlines of his classification of the aves, in the Fauna Suecica; and in 1758, it was published in the Systema Naturæ. In 1760, appeared the work of M. Brisson, which is held in high esti-

estimation by some of the continental writers. Since which time we have the valuable work of Mr. Pennant, which deservedly makes a part of every English naturalist's library. The Comte de Buffon has also published a splendid Ornithology, but the plates are inferior to those of Edwards.

The authors on the Amphibia are very few: Seba, Catesby, Gronovius, and Garden, comprize the list. The last order of this class has been referred to the Pisces, and treated upon by the writers under that division.

The authors of the fourth class are more numerous than the preceding. The first that we shall mention is Bellonius, whose work appeared in 1552. In 1554, Rondeletius and Silvianus both published upon this subject; and in 1558, the indefatigable Gesner was employed in this branch of Natural History. In 1605, Aldrovandus, in

1685, Mr. Willughby, and in 1710, Mr. Ray, made additions to Ichthyology by the publication of their respective observations. In 1760, Seba published his work. He was succeeded by Artedi, the friend of Linnæus, who is universally allowed to have treated the subject in a masterly, scientific manner. He was succeeded by Gronovius, Hasselquist, Catesby, and Garden. To this list we must add M. Broussonet, Professor of Natural History at Montpellier, and honorary member of this Society, who has published one decade of Ichthyologia, in which he has described ten rare and curious fishes, now in the collection of Sir Joseph Banks, Bart. He offers a new method of distinguishing the species according to the proportional length of parts, measuring from certain fixed points, as from the apex of the superior maxilla to the tail fin, ventral fin, dorsal or pectoral fin, &c. This distinction

distinction is founded upon the idea that the increment of all the fixed points in the growing animal is equal, or proportionate.

The authors on insects are very numerous. Linnæus was the first who undertook to determine the genera of insects, and assign them their proper characters. Swammerdam informs us, that no less than four hundred writers preceded him on this subject; and we find, that the study of butterflies was at one time so fashionable, that the Lady Merian actually sailed from Holland to Jamaica in pursuit of this splendid tribe of insects. Most of the authors have invented systems for themselves, and there is now publishing in France a work, entitled, *Papillons de l'Europe*, in which we have some very good plates finely coloured, and a sort of new arrangement. Poda, Sultze, Geoffroy, Scopoli, and Gronovius, are the chief systematic writers.

writers. Sir John Hill divides them into three classes : 1. Apterua, having no wings. 2. Pteraria, including all winged insects. 3. Gymnarthridia, including all insects which have soft and naked bodies, furnished with limbs. Mr. Ray has two principal divisions ; and Dr. Hook has presented us with a Micrography in Folio. Fr. Redi, a physician at Florence, has published several figures, with some new and curious experiments of his own. Malpighi and Bartholine have some fine observations, and we have likewise several interesting experiments on insects in the Philosophical Transactions of London, Paris, and Leipzig. Hoeffnagel, painter to the Emperor Rudolphus, has given plates of above four hundred species. Mr. Albin has likewise given a new history of the English insects, with very beautiful figures. We have also a work on English moths and butterflies,

flies, by Mr. Wilks, Lond. 1747, 1760. But the *Memoires pour servir à l'Histoire des Insectes*, par M. de Reaumur, à Paris, 1734, 1742, is esteemed the best and most philosophical account of the subject which ever appeared. Bonnet de Geers, Schæffers, Jungius, and Scopoli, with a whole troop of Germans, have been employed as auxiliaries in this pursuit; but to the young student we recommend a little work by Mr. Curtis, as the most useful introduction.

The writers on the class of vermes are only numerous on the order of Testacea. We have no authors of note on the Intestina. On the Mollusca Bohadschius is the principal; and on the Testacea we find Bonannus in 1684;* and Lister, in 1685, published his

* His work is entitled *Recreatio Mentis & Oculi in Observatione Animalium testacearum* a P. Phil. Bonnanno S. J. Rom. 1684.

his *Synopsis Methodica Conchyliorum*,
 Libr. III. Append. 2. Lond.—Ibid.
 1692, Fol.

In 1702, and 1705, Rumphius published on this subject. After whom appeared the following works :

Car. Nic. Langii *Methodus Nova & Facilis Testacea Marina in suas Classes, Genera, & Species distribuendi*.
 Lucern. 1722.

Jac. Theod. Klein *Sciagraphia Tubulorum Marinorum Musei Kleiniani*.
 Ged. 1731—4.

Jan Planci Arminienfis de *Conchis minus Notis Liber*. Venet. 1739. Romæ, 1760—4.

Nic. Gualteri *Index Testarum Conchyliorum Musæi sui*. Flor. 1742, Fol.

L'Histoire Naturelle éclaircie dans une de ses Parties Principales de la Lithologie, & la Conchyliologie, par M***, à Paris, 1742.

The plates of Argenville, which appeared in 1758, with those of Regenfusus,

fusus, executed at the expence of the King of Denmark, are splendid illustrations of Conchology. A copy of the latter is now in the University Library, Cambridge.

Columna, Barrelierus, Plancus, Klein, Ginannus, and Adanson, have likewise written on this subject; but to a beginner Da Costa's Introduction to Conchology is the most useful, and, with Lister and Argenville, will give as much information as most men wish to acquire on this very beautiful and pleasing topic.

On the Lithophytes we have "Al. Fred. Marsigli Histoire de la Mer, à Amsterdam, 1725, Fol. Observations sur la Formation du Corail, & des autres Productions appellées Plantes Pierreuses, par M. de Reaumur, 1727. And a work by Donatus.

On the Zoophyta we have "Examen de quelques Productions Marines, qui ont été puises au Nombre de
P Plantes,

Plantes, & qui font l'Ouvrage d'une
Sorte d'Insectes de Mer, par M. Bern.
de Jussieu, 1742.

· Effays on the Natural History of Po-
lypes, by Henry Baker. Lond. 1743-8.

Memoires pour servir à l'Histoire
d'une Espece de Polypes d'Eau douce,
par M. Trembley. Leyd. 1744.

Lettres d'Eugene à Clarence au Su-
jet des Animaux appellées Polypes. A
Straßb. 1745--8.

Car. Linnæi Diff. Corallia Balthica,
Resp. Henry Foug. Upf. 1745.—
Amæn. Acad. p. 177.

Ejusd. Diff. Tœnia Resp. Godof. Du-
bois. Upf. 1748.---Amæn Acad. p. 53.

Della Storia Naturale Marina dell
Adriatico Saggio del S. D. Vitaliano
Bonati. Venez. 1750.

An Essay towards a Natural History of
the Corallines, by John Ellis. Lond.
1755.

Jobi Basteri Opuscula Subseciva Ob-
servationes Miscellaneas de Animalcu-
lis,

lis, & Plantis Quibusdam Marines Eorumque Ovariis & Seminibus Continentia. Tom. I. L. i. 3. Tom. II. L. i. 3. Haerlem, I. 759. 1765.

Henr. Aug. Wrisberg Observationum de Animalculorum infusoriorum Genesi & indole Satur. Goetting. 1765.

Lettre de M. Derome de Lisle à M. Bertrand sur les Polypes d'Eau douce, 1766.

Pet. Sim. Pallas Elenchus Zoophytorum. Hag. com. 1768.

Aquatilium & Terrestrium aliquot Animalium Observationes, Fabio Columna Auctore. Rom. 1606.

Ul. Aldrovandi de Animalibus exsanguibus, mollibus, & crustaceis. L. Bonon. 1606, Fol.

Jo. Jonstoni Hist. Naturalis de exsanguibus Aquaticis, Lib. III. Francof. 1650, Fol.

Having gone through the plan proposed, it will be unnecessary for me to detain you any longer; I shall there-

fore conclude with observing, that in the study of Zoology the subject of Comparative Anatomy deserves particular attention; and as it is intimately connected with general Physiology, it becomes the more immediate object of medical men. The little work of Dr. Monro, as an elementary system, is the best with which I am acquainted. It is, however, to be regretted, that we have no translations of several useful works in the German language. There is one author in particular which I would recommend to the study of those who are able to peruse it: It is the work of Professor J. C. P. Erxleben, published at Gottingen in 1768, and contains the most scientific view of the three kingdoms of Nature with which I am acquainted. It is matter of no small regret to me that I did not meet with it sooner. But I am ready to acknowledge my obligations for the information which I have borrowed

borrowed from it in some parts of this work; and I am sorry that my ignorance of the German language did not enable me to study some other works, to which I have had access in the library of the learned President of the Royal Society, whose liberality and ardor in the pursuits of science do honor to the nation.

The hints which I have given will, I trust, be sufficient to recommend and facilitate this pleasing science to all ranks of men whom it may concern; and there are few indeed whom it does not affect. Any farther eulogy or instruction to the young student must appear unnecessary on the present occasion; I shall therefore conclude with one more physiological plagiarism:

“ Here then we rest: “ The Universal Cause
 Acts to one end, but acts by various laws.”
 In all the madness of superfluous health,
 The trim of pride, the impudence of wealth,

Let

Let this great truth be present night and day,
 But most be present if we preach or pray.
 Look round our world, behold the chain of love
 Combining all below, and all above ;
 See plastic Nature working to this end,
 The single atoms each to other tend,
 Attract, attracted to, the next in place,
 Form'd and impell'd its neighbour to embrace.
 See matter next, with various life endu'd,
 Press to one centre still, the General Good.
 See dying vegetables life sustain ;
 See life dissolving vegetate again.
 All forms that perish other forms supply,
 By turns we catch the vital breath and die :
 Like bubbles on the sea of matter born,
 They rise, they break, and to that sea return.
 Nothing is foreign ; parts relate to whole ;
 One all-extending, all-preserving soul
 Connects each being, greatest with the least ;
 Made beast in aid of man, and man of beast.
 The chain holds on, and where it ends unknown.

POPE'S ESSAY ON MAN, Ep. III. Begin.

F I N I S.

